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(E82-10194) STUDY OF GRAVITY AND MAGNETIC ANOMALIES USING MAGSAT DATA Quarterly Progress Report, Apr. - Jun. 1981 (Purdue Univ.) 9 p HC A02/MF A01 CSCL 08B N82-22628 Unclas G3/43 00194

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Subject: Quarterly Progress Report - April, May, June, 1981

Date: July 1, 1981

During the period of April, May, and June, 1981, our investigations have covered a broad range of activities leading to completion of the goals of our research effort. Most of our research has been directed toward the preparation of material that was presented in two papers at the special Magsat session of the AGU meeting held in Baltimore, Maryland on May 27, 1981 and two papers that have been accepted for presentation at the Fourth Scientific Assembly of IAGA on August 4, 1981.

Abstracts of the two papers presented at the AGU meeting are attached. The paper by R.R.B. von Frese, W.J. Hinze and L.W. Braile entitled "Regional Magnetic Model of the Mississippi Embayment" presented the results of modeling satellite-elevation magnetic and gravity anomaly data utilizing the constraints imposed by near-surface data and seismic evidence. The magnetic minimum can be accounted for by either an intra-crustal lithologic variation or an upwarp of the Curie Point isotherm. The pros and cons and implications of the thermal upwarp were discussed. Modeling was performed utilizing program SPHERE which takes into account the sphericity of the earth.

The paper by J.L. Sexton, W.J. Hinze, R.R.B. von Frese and L.W. Braile entitled "Long-Wavelength Aeromagnetic Map" showed the compilation of the scalar data obtained from the NOO's - vector magnetic survey of the conterminous U.S. in various forms. The long-wavelength (> 200 km) anomalies of this data set have been contoured and processed by various frequency filters to enhance particular characteristics. In addition, a preliminary inversion of the data has been completed and the anomaly field calculated at 450 km from the equivalent magnetic sources to compare with the POGO satellite data. This upward continued anomaly field shows excellent correlation with the observed field after removal of an ultra-long-wavelength component. This ultra-long component may be a crustal anomaly or more likely a vestige of an error in the updated IGS-75 field used in reducing the aeromagnetic data to anomaly form.

The paper by R.R.B. von Frese, W.J. Hinze, J.L. Sexton and L.W. Braile entitled "U.S. Aeromagnetic and Satellite Magnetic Anomaly Comparisons" which will be presented at the IAGA meeting is under preparation. A finalized inversion of the NOO scalar magnetic data of the conterminous U.S. has been completed and comparisons are now being made between the data computed at satellite elevations from these inversion results and the observed satellite magnetic data.

Considerable progress has been made in studying the satellite magnetic data of South America and adjacent marine areas for presentation at the IAGA meeting of the paper "Satellite Elevation Magnetic and Gravity Models of Major South American Plate Tectonic Features" by M.B. Longacre, W.J. Hinze, R.R.B. von Frese, L.W. Braile, E.G. Lidiak and G.R. Keller. The averaged Magsat scalar data from 20°W to 100°W longitude and 30°N to 45°S latitude has been reduced to the pole and normalized to a constant inducing magnetic field. A Free-air gravity anomaly data set of this area has been prepared at 1° intervals from all available data. Preliminary versions of the 1° Free-air gravity anomaly map (20 mgal contour interval) and the high-cut ($\lambda \leq 8°$) filtered anomaly maps are attached. This data set is being inverted and will be upward continued to the mean Magsat elevation for comparison purposes. These maps will be compared with the major geologic features of the area, utilizing a preliminary tectonic sketch map prepared with the assistance of the Part II-Study Group (Lidiak and Keller), the results of modeling of the Andean subduction zone and the Amazon River Aulacogen, and a preliminary crustal thickness map prepared by the Part II-Study Group.

A paper entitled "Regional North American Gravity and Magnetic Anomaly Correlations" by R.R.B. von Frese, W.J. Hinze and L.W. Braile submitted to the Geophysical Journal of the Royal Astronomical Society has been revised and resubmitted in final form for publication. A second paper "Long-Wavelength Aeromagnetic Anomaly Map of the Conterminous U.S.A." by J.L. Sexton, W.J. Hinze, R.R.B. von Frese and L.W. Braile has been prepared and distributed for review. A third paper dealing with the comparison of the upward continued NOO scalar magnetic data with the satellite magnetic data is nearing completion. A brief note regarding the significance of correlating magnetic with gravity anomaly data using a profile across the U.S. along the 37°N parallel has been prepared for submission to the Gravsat program office. A copy of this note is attached. Finally, our group is preparing a variety of illustrations for the Magsat B Study Group.

During the past quarter, two of the investigators (WJH and RRBvF) attended the P.I. meeting and the Magsat special session of the AGU in Baltimore, MD and we met with Part II-Study Group to coordinate and integrate activities.

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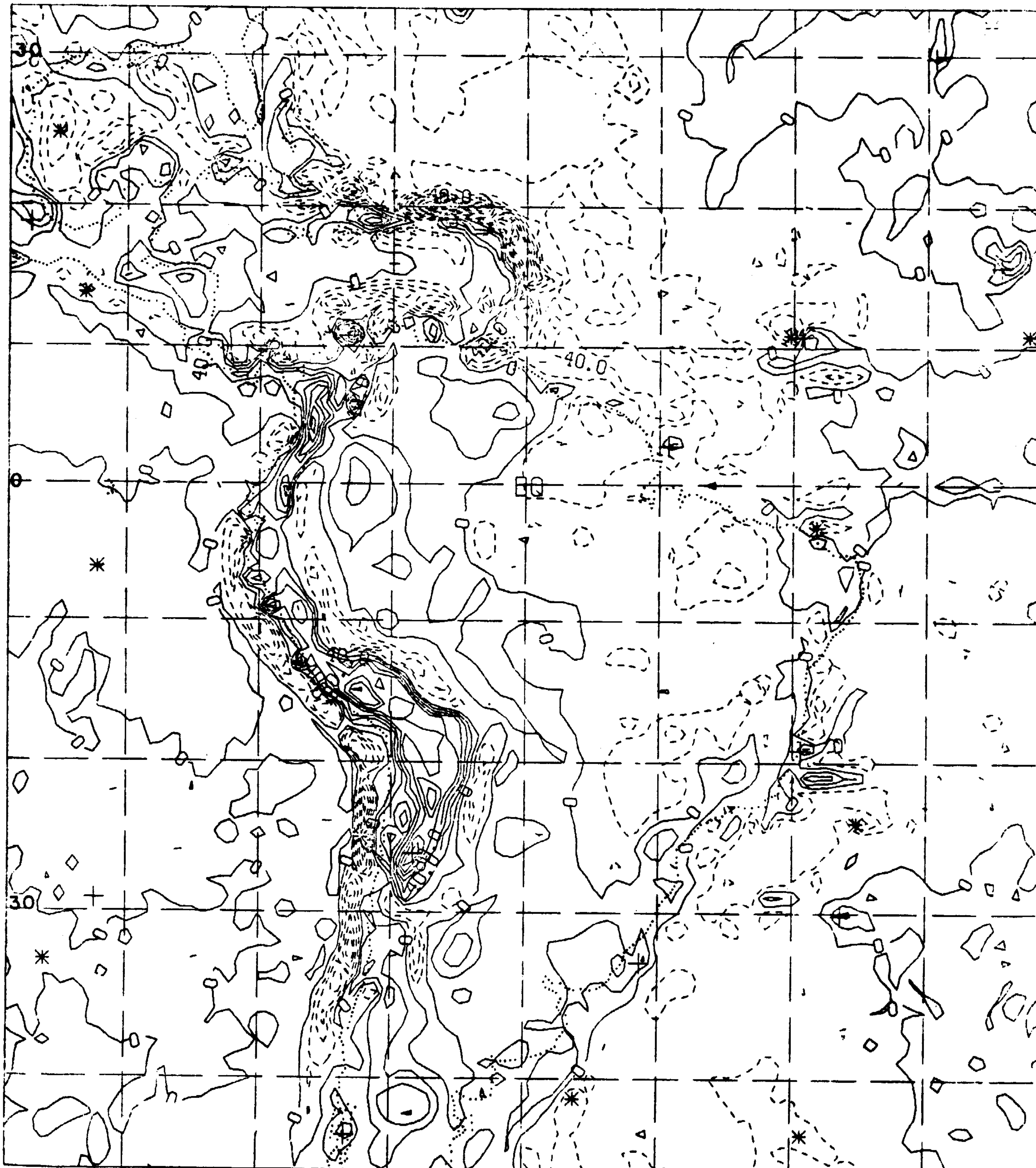
FREE AIR GRAVITY MAP (PRELIMINARY)



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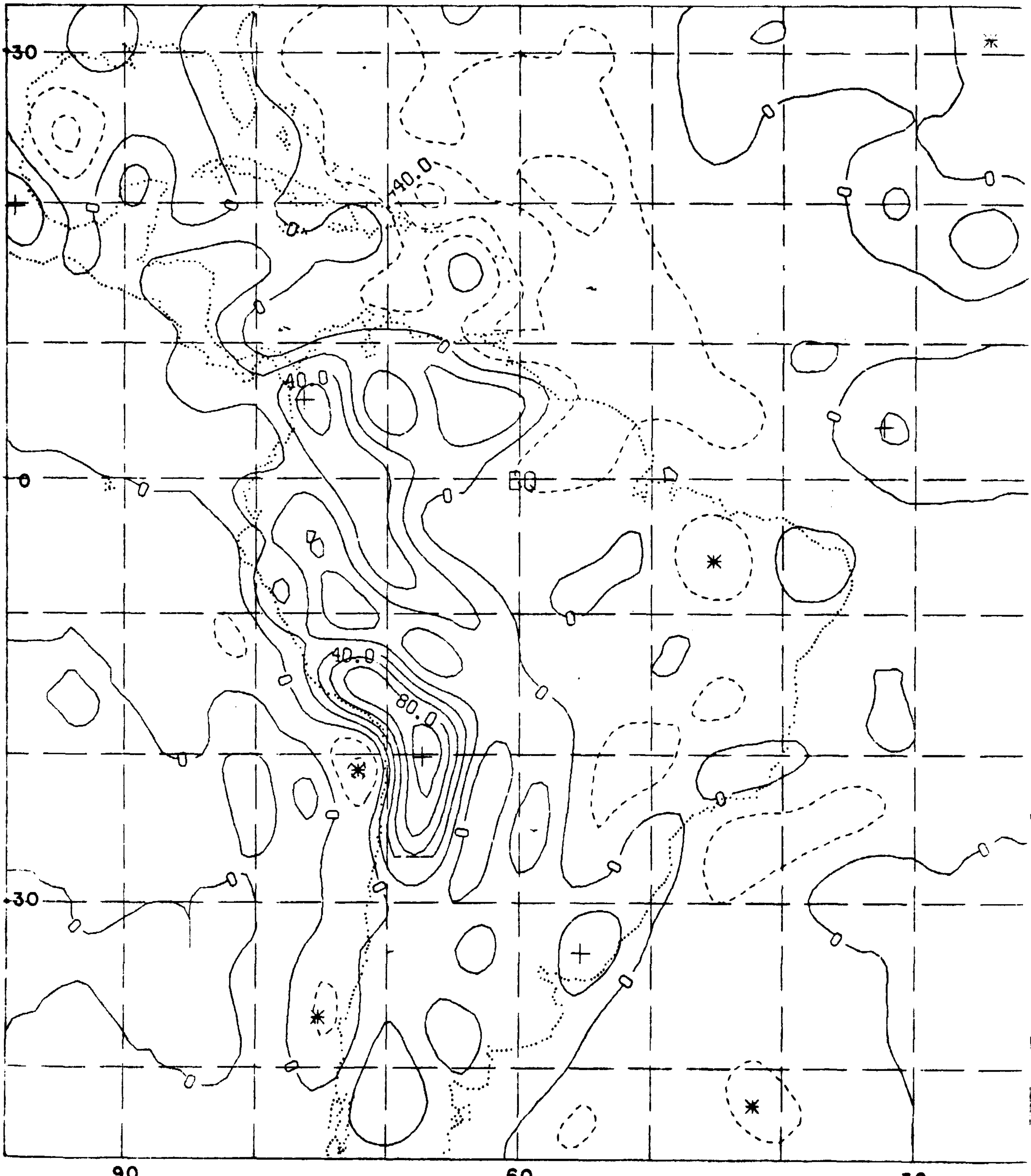
HIGH - CUT (λ≠8°) FILTERED 1° FREE AIR GRAVITY MAP (PRELIMINARY)



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REGIONAL MAGNETIC MODEL OF THE MISSISSIPPI EMBAYMENT

R.R.B. von Frese, W.J. Hinze and L.W. Braile (Dept. of Geosciences, West Lafayette, IN 47907)

Recently available Magsat and U.S. Naval Oceanographic Office - Vector Magnetic Survey total intensity magnetic anomaly data confirm the existence of a long-wavelength magnetic minimum associated with the Mississippi Embayment (ME) originally observed in POGO satellite-elevations data by Regan and others. Ervin and McGinnis using both geophysical and geologic data suggest that the ME is the site of a late Precambrian rift which was reactivated to form a Mesozoic aulacogen (the ME). A crustal model for the ME developed by Austin and Keller from surface wave, seismic refraction, and gravity data which involves a thinning of the upper crust, an increase in the density of the lower crust, and a thickening of the entire crust is a starting point for modeling the observed magnetic minimum in the POGO data. The magnetic minimum can be accounted for by a decrease in magnetization along the axis of the ME at the base of the crust. Either an intra-crustal lithologic variation or an isotherm upwarp are viable sources of the minimum. The latter is supported by intense seismicity in the New Madrid region and increasing evidence for abnormally high heat flow which suggests the possibility of modern thermal interactions between the mantle and the crust in the ME.

LONG-WAVELENGTH AEROMAGNETIC MAP OF THE U.S.A.

J.L. Sexton, W.J. Hinze, R.R.B. von Frese and L.W. Braile (Dept. of Geosciences
West Lafayette, IN 47907)

Increasing attention has been placed upon obtaining geologic information from long-wavelength magnetic anomalies as a result of the availability of satellite-elevation magnetic observations and composited near-surface aeromagnetic maps. The U.S. Naval Oceanographic Office - Vector Magnetic Survey of the United States provides an excel'ent new source of total intensity magnetic observations for the sutdy of long-wavelength anomalies over most of the conterminous U.S. These data which are available at 0.1 km intervals along 1° meridians have been screened for periods of intense diurnal magnetic activity and reduced to anomaly form utilizing the updated IGS-75 geomagnetic field model which represents the earth's core-derived field by a degree and order 12 spherical harmonic. These magnetic anomaly fields have been high-cut filtered utilizing a 50% cutoff at 200 km wavelength. Profile maps of the filtered and unfiltered maps plus the contour map of the filtered data show many interesting correlations with regional geologic features and other geophysical data. A variety of processed maps are derived from the filtered data to aid in geological interpretations. The most intense positive, long-wavelength magnetic anomaly occurs over mafic rocks in the basement of central Kentucky and Tennessee. In contrast, prominent negative magnetic anomalies, for example, occur over the Mississippi Embayment, central Rockies, and marginally to the magnetic positive anomaly associated with the Mid-Continent Rift.

REGIONAL CORRELATION OF SATELLITE-ELEVATION GRAVITY AND MAGNETIC ANOMALIES

by

R.R.B. von Frese, W.J. Hinze and L.W. Braile (Department of Geosciences, Purdue University, West Lafayette, IN 47907)

The geological interpretation of potential field anomalies is beset with problems of ambiguity inherent in theory as well as translation of physical models into geological terms. One technique to minimize this limitation in continental terrain is to correlate anomalous gravity and magnetic anomaly fields. Recently, von Frese et al (1981) have prepared gravity anomaly and radially polarized magnetic anomaly maps of the U.S. and adjacent areas at satellite elevations (450 km) and considered their correlation and relationship to regional heat flow values.

The profile shown in Figure 1(A) presents the 450 km-level radially polarized magnetic anomaly and first radial free-air gravity anomaly derivative along the 37°N parallel across the U.S. (238°-284°E) which have been derived from POGO satellite magnetic and surface 1-degree mean free-air gravity anomaly data sets. Assuming homogeneous anomaly sources polarized in the direction of the earth's magnetic field, the radially polarized magnetic and the first radial free-air gravity derivatives are directly related through the magnetization to density contrast ratio by Poisson's theorem. The vertical (radial) derivative of the profiles in Figure 1(A) are shown in Figure 1(B) to increase the perceptibility of the anomalies. Figures 1(C) and (D) show the average elevation, crustal thickness, average crustal velocity, and P_N velocity along the 37°N parallel. The crustal parameters have been obtained from a map compilation of all available crustal seismic refraction, reflection and surface wave data.

As pointed out by von Frese et al (1981), these profiles show a remarkably strong inverse correlation. Two types of inversely correlated gravity and

magnetic anomalies are evident in Figure 1. One type is associated with negative gravity anomalies and positive magnetic anomalies as illustrated by the region between the Southern Rocky Mountains ($\approx 255^{O}E$) and the Valley and Ridge Province ($\approx 277^{O}E$). In a general way, this area is characterized by a thicker crust and a higher average crustal velocity. The second type of inverse correlation is characterized by negative magnetic anomaly and positive gravity anomaly associations as illustrated by the anomalies over the Mississippi Embayment which breach the first general type of inverse anomaly relationship. The Mississippi Embayment is the site of a late Precambrian aulacogen which has been reactivated in post-Paleozoic time. A similar correspondence is observed in the Eastern Colorado Plateau and Southern Rocky Mountain region. However, in direct contrast to the Mississippi Embayment area this region is characterized by an anomalously low average crustal velocity and thin crust. West of $250^{O}E$ the relationship between gravity magnetic anomalies breaks down, perhaps as a result of higher temperatures within the crust and rapidly varying tectonic regimes.

These examples are illustrative of the role satellite gravimetry can play in the investigation of lithospheric structure and composition, as well as the enhanced interpretation possible through correlation of potential fields.

GEOLOGICAL/GEOPHYSICAL CORRELATIONS ALONG 37 DEG N